Aug. 6, 1946. A. D. SMITH 2,405,272

ICE MANUFACTURE

Filed July 29, 1943 4 Sheets-Sheet 1

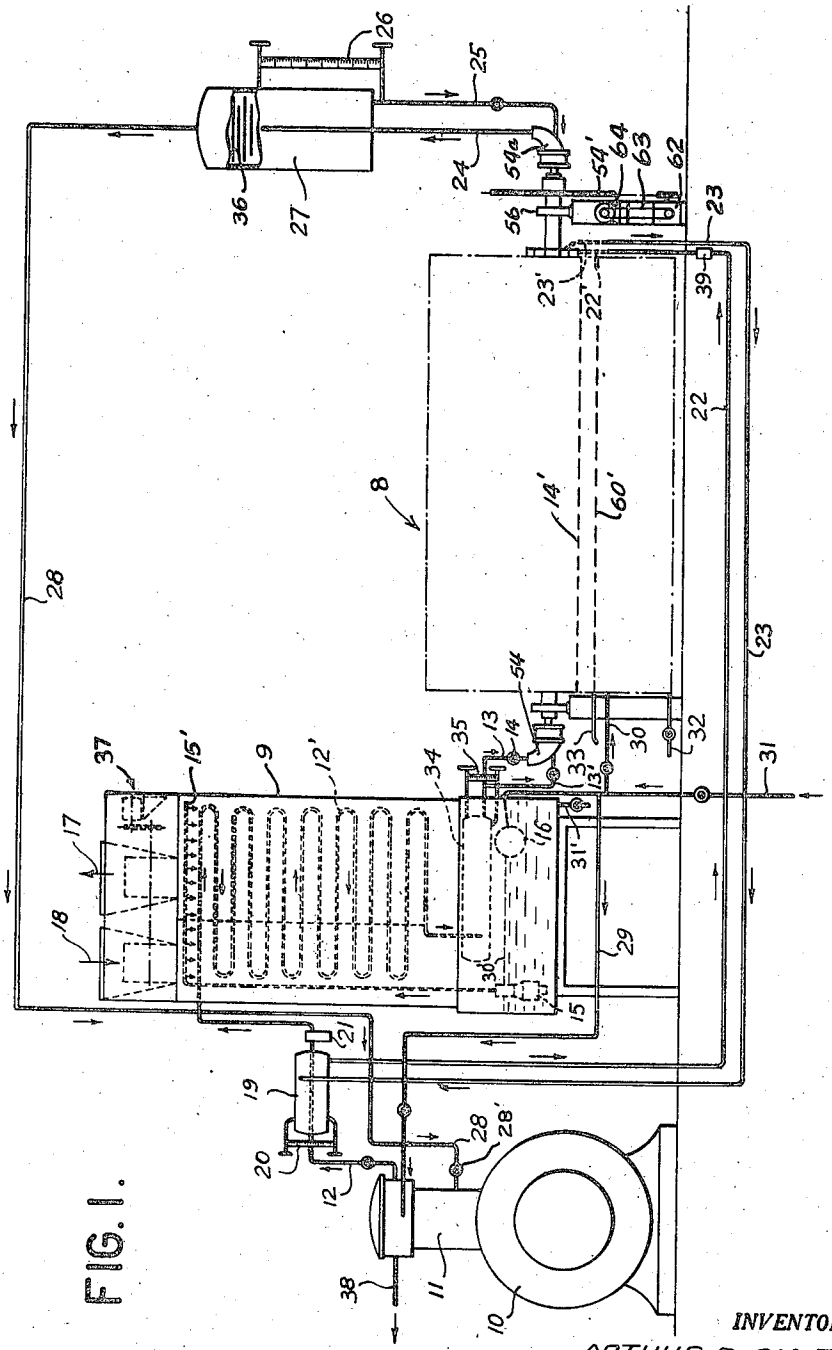


FIG. 1.

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ICE MANUFACTURE

Filed July 29, 1943 4 Sheets-Sheet 2

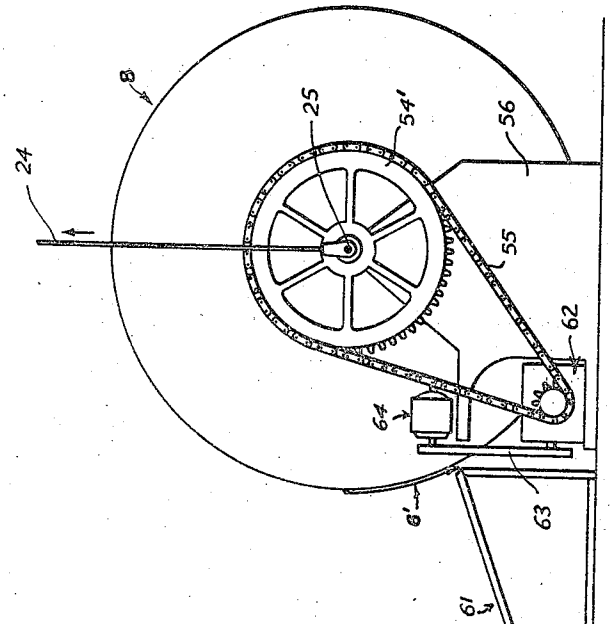


FIG. 4.

FIG. 2.

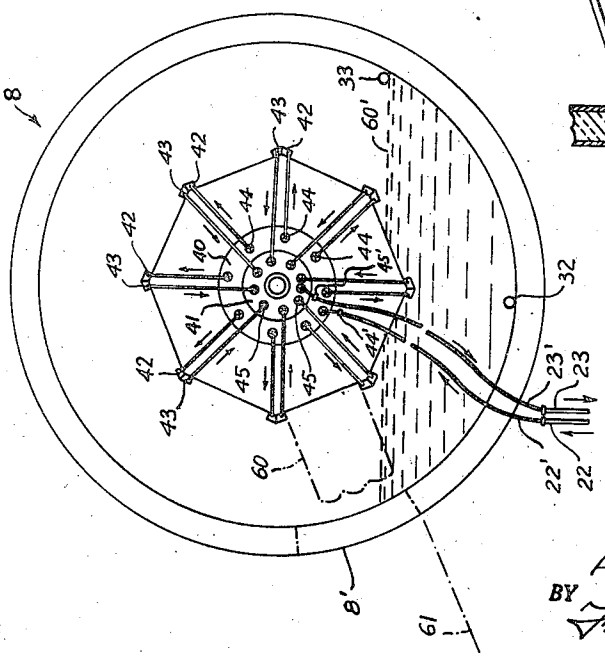
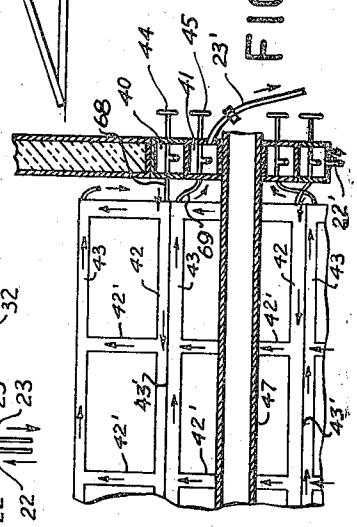


FIG. 3.



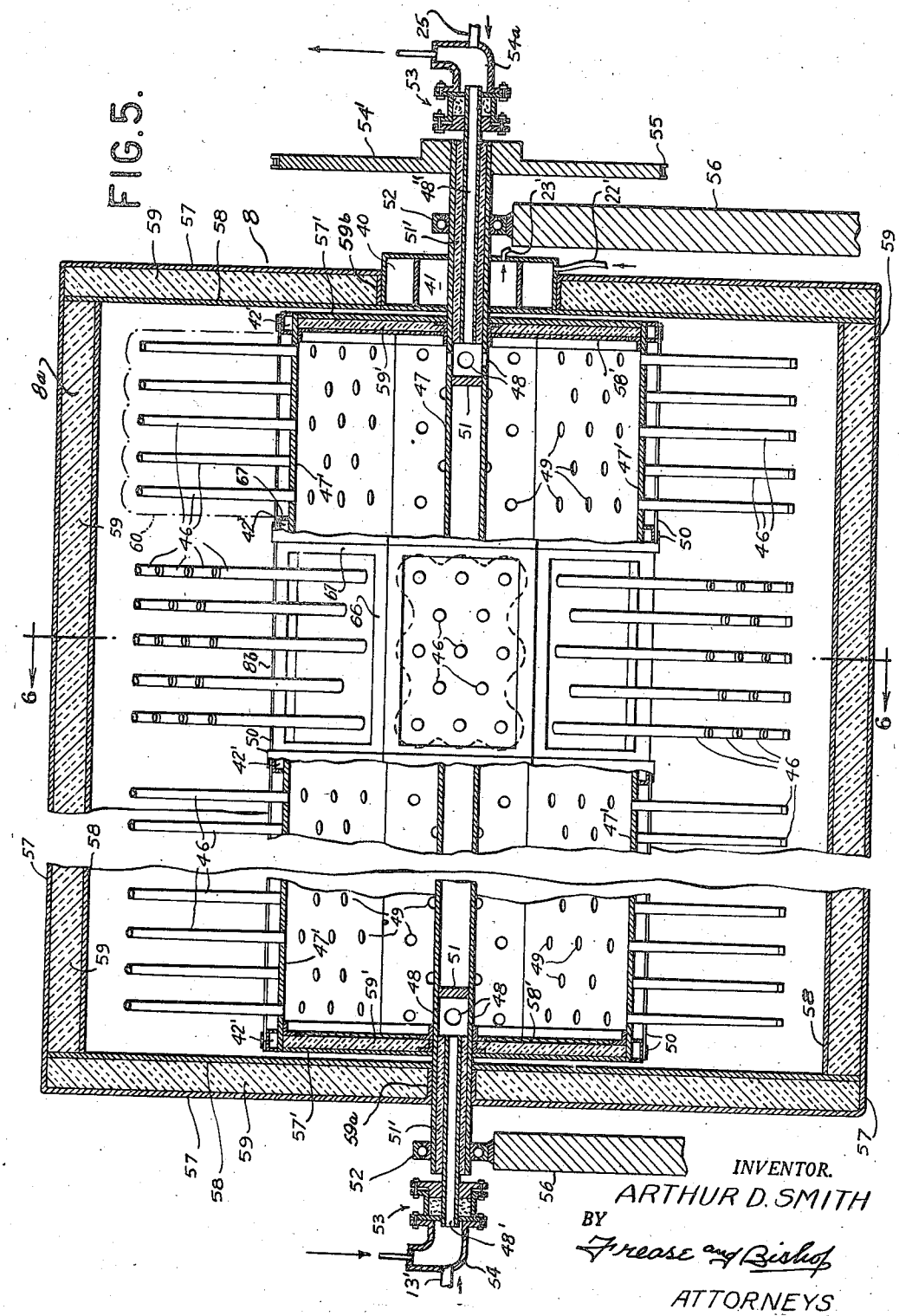
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ICE MANUFACTURE

Filed July 29, 1943 4 Sheets-Sheet 3

FIG. 5.



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ICE MANUFACTURE

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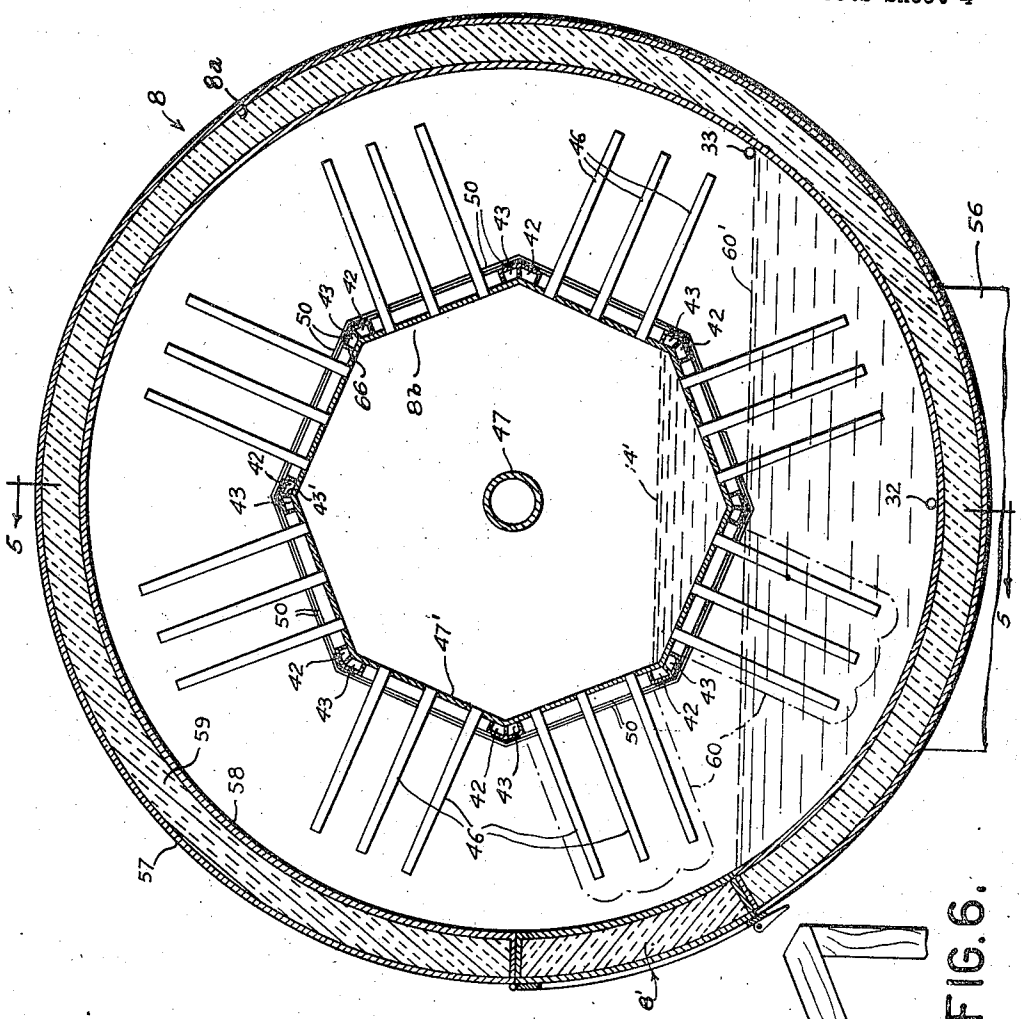


FIG. 6.

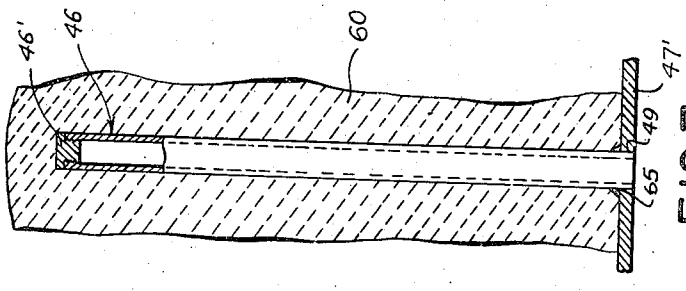


FIG. 7.

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Patented Aug. 6, 1946

2,405,272

UNITED STATES PATENT OFFICE

2,405,272

ICE MANUFACTURE

Arthur D. Smith, Canton, Ohio, assignor to Barium Steel Corporation, Canton, Ohio, a corporation of Delaware

Application July 29, 1943, Serial No. 496,564

4 Claims. (Cl. 62—172)

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The invention relates to the manufacture of ice and more particularly to a method of making blocks of ice for commercial use of any desired size and weight convenient for handling and use.

Heretofore, a large number of special cans filled with water and suspended in a large tank in which cold brine is circulated have been used and required in the common practice of making blocks of ice (11" x 22" x 43") for commercial use ordinarily weighing about 300 pounds. Compressed air is forced through the water in the cans while the freezing progresses from the outside inward to eliminate air bubbles from the ice and to center impurities and the like in the center or core of each ice block. When the freezing is nearly completed, the impure water in the center or core of each ice block is drawn off and the center core is refilled with clean water after which the freezing of the blocks is completed. The cans are then transferred from the large tank to a thawing station, where the ice blocks are removed from the cans and stored or shipped to the ultimate place of use.

The manufacture of commercial ice blocks in accordance with prior common practice involves a very large investment and a great deal of expensive equipment, including large brine circulation tanks, ice cans, covers for the cans, compressed air equipment, overhead cranes, thawing dump equipment, core pumps, core suckers, core fillers, water and air filters, brine agitators, and numerous other accessories and piping. Such equipment is in addition to the refrigerating equipment necessary for supplying brine at the proper temperature for circulation in the large tanks.

No satisfactory way has ever been provided for the manufacture of commercial ice blocks using direct expansion of the primary refrigerant and eliminating the use of brine as an intermediate or secondary cooling medium or refrigerant.

Also, no satisfactory way has ever been provided for the manufacture of commercial ice blocks very rapidly and with a relatively small capital investment in equipment, as compared with the investment in equipment required in conventional practice.

Moreover, no satisfactory way has ever been provided for manufacturing commercial ice blocks in small plants at or near to the place of ultimate use of the ice, as distinguished from large central plants where the ice is made and stored and shipped at substantial cost to the place of ultimate use.

Also, no satisfactory way has ever been provided for making commercial ice blocks in a portable or mobile unit.

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Finally, no satisfactory way has ever been provided for making ice blocks of a desired or selected weight for any one installation, say any weight within the approximate range of 50 to 300 pounds, by a relatively simple or minor change in the design of an ice manufacturing unit.

In referring to "commercial ice blocks" herein, the term includes blocks weighing any desired or selected weight within the approximate range of 50 to 300 pounds, as distinguished from ice cubes which are relatively diminutive in size.

Accordingly, it is a primary object of the present invention to provide a method of making commercial ice blocks without using ice cans, and without using or requiring such auxiliary equipment as overhead cranes, huge brine circulating tanks, compressed air equipment, thawing dump equipment, core processing equipment and the like, which are required in the manufacture of ice in accordance with common practice.

Another object of the present invention is to provide a method of making commercial ice blocks which greatly reduce the initial plant cost, the cost of production, and consequently the cost per ton of ice manufactured.

Also, it is an object of the present invention to provide a method of producing commercial ice blocks of purer quality than ice produced in accordance with common practice.

Further, it is an object of the present invention to provide a method of making commercial ice blocks utilizing direct expansion of the primary refrigerant and eliminating the necessity of using and circulating a large volume of brine or salt water.

Also it is an object of the present invention to provide a method of making commercial ice blocks free of air cells and foreign substances without the use of any core or sucking or aeration processing equipment.

In addition, it is an object of the present invention to provide a method of making commercial ice blocks with materially less freezing surface than is required in accordance with common practice.

A further object of the present invention is to provide a method of freezing commercial ice blocks of a selected weight in materially less time, say one-quarter to one-eighth of the time required in acccordance with common practice to produce a block of the same weight with the same temperature of refrigerant.

Another object of the present invention is to provide a method of making commercial ice blocks, which may be operated intermittently

without substantial power loss during shut-down periods by one man to produce ice required by a user of say 50 tons per day.

Also, it is an object of the present invention to provide a method whereby a relatively large amount of ice, say 5 to 10 tons per day may be made with a relatively small amount of equipment and within a small space such as on a trailer or automobile truck.

A further object of the present invention is to provide a method of making commercial ice blocks under conditions for obtaining a maximum rate of heat transfer enabling quick freezing of the ice.

Also it is an object of the present invention to provide a method of making commercial ice blocks in which the freezing progresses outwardly from a plurality of central freezing zones by progressively freezing thin films of water on the outside of growing cores or cylinders of ice, as distinguished from freezing from the outside inward to a central hollow core in accordance with common practice.

Furthermore, it is an object of the present invention to provide a method of freezing commercial ice blocks in which the water is constantly being agitated to form air free ice as the freezing progresses outward on growing cylinders of ice.

Also, it is an object of the present invention to provide a method of freezing commercial blocks of ice in which pure ice is continuously being formed from water containing impurities or precipitates as the freezing progresses outward on growing cylinders rather than being trapped in the core as freezing progresses from the outside inward in accordance with common practice.

Also, it is an object of the present invention to provide a method of making commercial ice blocks of any desired weight. Such desired weight may be selected for any installation within the range of say approximately 50 to 300 pounds. The time of freezing the blocks may be approximately constant, other conditions being the same, irrespective of the selected weight.

Moreover, it is an object of the present invention to provide a method of making commercial ice blocks in any desired time for any installation selected within the range of say approximately two to eight hours, irrespective of the selected weight of block, other conditions being the same.

And finally, it is an object of the present invention to provide a method of manufacturing ice radically different from common practice, which is much quicker, more economical, and produces purer ice in much less space, at a much less cost of equipment and of ice produced therein and with much less labor, attention, power, equipment and overhead than in accorance with common or conventional practice.

These and other objects may be obtained by the methods, procedures, steps, and operations hereinafter described in detail, and set forth in the appended claims, certain steps of which may be best understood by reference to the drawings of improved apparatus for carrying out the method, in which

Figure 1 is a diagrammatic view illustrating an installation of improved apparatus for carrying out the improved method;

Fig. 2 is a diagrammatic view of parts of the apparatus shown in Fig. 1, illustrating the connections and arrangement for thawing ice blocks made by the improved method and apparatus;

Fig. 3 is a fragmentary diagrammatic view further illustrating the arrangement for thawing ice blocks manufactured by the improved apparatus;

Fig. 4 is an end view of the freezing apparatus shown in Fig. 1;

Fig. 5 is a fragmentary longitudinal sectional view taken as on the line 5—5, Fig. 6, illustrating the improved freezing apparatus;

Fig. 6 is a sectional view taken on the line 6—6, Fig. 5; and

Fig. 7 is an enlarged view of one of the freezing pipes illustrating a portion of a block of ice formed thereon.

Similar numerals refer to similar parts throughout the drawings.

Referring first to Fig. 1 wherein improved apparatus for manufacturing ice in accordance with the present invention is illustrated diagrammatically, the freezing unit is generally indicated at 8, represented by dot-dash outline. The installation may also include a motor or prime mover 10 driving a gas compressor 11 having a hot compressed gas discharge line 12 and a gas intake line 28. The compressor is cooled preferably by water introduced to a cooling jacket through a water intake line 29 supplied by main supply 31 and discharged through the water outlet pipe 38.

The hot compressed gas passes along line 12 through a heat exchanger 19 for a purpose to be hereinafter described, and thence through an oil trap 21 to condenser coils or tubes 12' in the evaporative-condenser generally indicated at 9 from whence the condensed liquid refrigerant collects in a receiving tank 34.

The condenser 9 has a pit maintained filled with water to a level 30', supplied from main water supply 31 and drained at 31'. The water level 30' in the pit is maintained in the usual manner by a float valve indicated at 16. A water circulating pump 15 is located in the condenser pit and supplies water fom the pit to the discharge spray pipes 15' for spraying and dropping on and around the coils or condenser tubes 12' to assist in absorbing the heat from the hot gas being condensed therein.

The condenser 9 is also provided with an incoming air duct 18 and an outgoing air duct 17, each of which may be provided with a fan or blower operated by a motor 37 or circulating air through the condenser 9 around the condenser tubes 12' to carry away the heat of condensation of the refrigerant.

The level of the liquid refrigerant in receiving tank 34 may be observed by sight glass 35 and the condensed liquid refrigerant normally passes from the receiving tank 34 to the freezing unit 8 through liquid refrigerant line 13 and automatic expansion valve 14 to freezing unit connector 54. A by-pass line 13' equipped with a valve also communicates between receiving tank 34 and freezing connector 54 for a purpose to be later described.

Expanded or spent refrigerant gas leaves the freezing unit 8 through a similar connector 54a and passes through gas return line 24 to an accumulator 27 equipped with baffles 36, wherein entrained refrigerant liquid is separated from the gas and collects in accumulator 27 and the liquid may be returned to the freezing unit 8 through by-pass line 25. The level of liquid in the accumulator may be observed by gauge or sight glass 26. The refrigerant gas returns from accumulator 27 through line 28 to the compressor 11.

Referring particularly to Figs. 4, 5, 6 and 7,

wherein the freezing unit generally indicated at 8 is shown in detail, the freezing unit 8 may include supports 56 for bearings 52, in which the hollow shaft 47 is journaled. A sprocket 54' may be fixed to one end of shaft 47, and the sprocket 54' may be driven by chain belt 55, speed reducer 62, belt 63 and motor 64 for rotating hollow shaft 47.

Shaft 47 may be provided near each end with a partition 51 and with openings 49 adjacent the outer side of each partition. A refrigerant inlet pipe 48' insulated at 51' may be mounted within one end of the hollow shaft 47 and a similar refrigerant gas outlet pipe 48'' insulated at 51' may be mounted within the other end of hollow shaft 47. Inlet connector 54 and outlet connector 54a are mounted on and connected respectively to inlet and outlet pipes 48' and 48'' by stuffing boxes 53.

The freezing unit 8 further preferably comprises an outer preferably cylindrical stationary shell or drum 8a comprising side and end walls formed by outer sheet metal walls 57, inner sheet metal walls 58 and intervening insulation material 59.

Referring particularly to Fig. 5, shaft 47 is adapted to rotate within the aperture 59a formed in the left hand or inlet end wall of the stationary outer drum 8a. The outlet end of shaft 47 is provided with a circular header 41 surrounded by another circular header 40 for a purpose to be later described, which headers 40 and 41 are rotatable along with shaft 47 within enlarged aperture 59b provided in the inlet end wall of outer drum 8a.

The freezing unit 8 also includes a rotatable multi-sided evaporator drum 8b mounted on shaft 47 within the outer drum 8a; and the multi-sided evaporator drum 8b includes end walls formed by outer plates 57', inner plates 58' and intervening insulation material 59'. The side walls of the multi-sided drum 8b are formed by flat plates 47'. The polygonal cross sectional shape of the multi-sided evaporator drum 8b is shown as being octagonal or eight sided, but the polygon may have more or less sides if desired.

Each plate 47' is formed with a number of groups of holes 49, and hollow freezing tubes 46 are connected to each plate 47' communicating with each hole 49 and project outwardly at right angles to each plate 47' generally radially of hollow shaft 47.

Referring particularly to Fig. 7, each freezing tube 46 may be mounted in any suitable manner on the drum plates 47'. As shown, the tubes 46 are preferably inserted in holes 49 and welded to the plates 47' as at 65. The outer end of each tube 46 may be closed in any suitable or convenient manner, as by threaded plugs 46'. The freezing tubes 46 are shown as being and preferably are cylindrical tubes. However, if brine is used as a secondary refrigerant as later explained, they may have any other desired shape in cross section, as for instance they may be square, rectangular or oval in shape. Also, the tubes 46 may be slightly tapered from their inner to their outer ends. Furthermore, the tubes 46 are preferably made of copper or brass for obtaining the maximum rate of heat transfer through the walls thereof.

The flat drum walls 47' are provided at their outer faces where they meet the next adjacent flat drum wall 47' with longitudinal double channel members 66, and with spaced peripherally extending channel members 67. Members 66

and 67 form a series of shallow rectangular projecting ledges around and segregate each group of freezing tubes 46. The outer surfaces of the channel members 66 and 67 are preferably covered with insulation material 50. Thus, the channel members 66 and 67 form a series of circulation passages diagrammatically indicated in Figs. 2 and 3 as ingoing passages 42, cross passages 42' and outgoing passages 43. The center flange or partition 43' of each longitudinal double channel 66 serves to form the passages 42 and 43 within each double channel 66.

Referring to Fig. 5, each flat drum plate 47' has a number of groups, such as 4, 5 or 6 groups (or more or less) of freezing tubes 46 mounted thereon; and each group of freezing tubes serves to form one block of ice, as will be later described. The several groups of freezing tubes located longitudinally on one flat drum wall 47' are referred to as a bank of groups.

Now referring to Figs. 3 and 4, each bank of groups has a separate circulation system within passages 42, 42' and 43. An inlet tube 68 (Fig. 3) connects the ingoing passage 42 of each bank through inlet valve 44 with circular inlet header 40; and an outlet tube 69 connects the outgoing passage 43 of each bank through outlet valve 45 and circular outlet header 41.

Warm liquid such as water or other heat transfer medium, may be drawn from heat exchanger 19 through warm liquid supply line 22 by liquid circulating pump 39 to flexible pipe 22', detachably connected at 44' (Fig. 2) with a valve coupling communicating with circular inlet header 40. Another flexible pipe 23' is detachably connected at 45' with a valve coupling of circular outlet header 41 and leads to warm liquid return line 23, also connected with heat exchanger 19. The level of liquid in heat exchanger 19 may be observed in sight glass 20.

The numeral 14' in Figs. 1 and 6 indicates the approximate level of liquid refrigerant in rotatable multi-sided evaporator drum 8b during operation; while the numeral 60' indicates the approximate water level within the outer drum 8a of the freezing unit. Water is supplied to the drum 8a through pipe 30 communicating with the main water supply 31, and the drum may be drained at 32. The level 60' is preferably maintained by an overflow opening 33.

The ice blocks which form on each group of freezing tubes are diagrammatically indicated at 69 in dot-dash lines, and may be removed in a manner to be hereinafter described by opening air-tight hinged cover 8', whence they may be transferred to a place of storage, shipment or use along chute 61.

In operation, the cold liquid refrigerant, which may be ammonia or other refrigerant at the usual temperature of approximately 14° F. is introduced into the interior of the multi-sided drum 8b to maintain a liquid refrigerant level 14' approximately as shown in Fig. 6. Water is maintained in the outer drum 8a at the approximate level 60'. The multi-sided drum 8b is rotated and during rotation the banks of groups of freezing tubes 46 on each flat drum wall 47' successively dip down into, pass through, and emerge from the water in the lower part of the outer drum 8a. Meanwhile, the liquid refrigerant flows into and fills the interior of the freezing tubes 46 as each bank of groups of tubes passes through the lower approximate quarter arc of rotation of the multi-sided drum and as the banks of groups swing through the upper left hand quarter arc of rota-

tion, the liquid refrigerant flows out of the freezing tubes and drains back into the interior of the multi-sided drum, accompanied by evaporation of some of the liquid refrigerant.

Thus, as any one freezing tube 46 completes one revolution, the liquid refrigerant flows or circulates in and out of the tube; and ideal conditions for a maximum rate of heat transfer are established because the liquid refrigerant is flowing and because the small streams thereof present a relatively large liquid surface for evaporation.

As a result of these operations, a thin film of ice commences to form around the outer surface of each freezing tube 46, under ideal conditions of heat transfer. As each tube 46 dips into the water bath and emerges from the water, a further film of water is carried out of the water bath on the outer surface of the ice forming on each tube 46, which further film in turn freezes as the multi-sided drum continues to rotate. Thus, the ice freezes progressively outwardly from the surface of each freezing tube 46 by the successive freezing of thin films of water on the outside of the growing core or cylinder of ice.

Operation of the unit is continued until each ice cylinder grows in size to meet the ice cylinder on and fill out the space between adjacent freezing tubes 46 of the group, to finally form a block of ice on each group of freezing tubes 46, substantially as shown in dot-dash lines at 60 in Figs. 5 and 6. The shallow projecting ledges around each group of freezing tubes 46 formed by members 66 and 67, serve to segregate and separate each block of ice from the next adjacent block of ice in each bank on one flat drum wall 47' and to also segregate the blocks of each bank from the blocks of the adjacent banks.

Meanwhile, the continuous movement of the freezing tubes 46 through the bath of water serves to agitate the water, with the result that no minute air bubbles are contained within the thin film of water successively picked up by each freezing tube 46. Accordingly, cloudy ice is avoided and clear ice is formed on the freezing tubes, eliminating the necessity of using special equipment for removing entrained air from the water being frozen, as is necessary in the common practice of making ice.

Moreover, as impurities dissolved in water lower its freezing point, the thin film of ice formed on each tube 46 during that part of its revolution when above the water is washed by the water on its immersion during the balance of the revolution and the impurities rejected to the surface of the film are washed off and concentrate in the water. When the impurities become so concentrated in the water as to exceed their solubilities the excess impurities precipitate to the bottom of the water bath.

If desired, a sterilizing lamp may be mounted within the outer drum 8a to sterilize the water therein and enable the formation of sterile ice.

When the freezing of the ice blocks is completed, the expansion valve 14 is closed, the compressor 11 is stopped, and valve 28' is closed. Gate valve in by-pass line 13' is then opened up wide permitting a relatively large volume of warm refrigerant liquid to flow by gravity from receiving tank 34 into the interior of multi-sided drum 8b. The liquid refrigerant in receiving drum 34 is normally at a temperature of between 80 to 100° F., and as it flows into the interior of the multi-sided drum 8b, it will warm the liquid refrigerant therein and in turn be cooled by the cold liquid refrigerant therein. Some evaporation will also take place accompanied by some lowering in temperature. However, gas pressure within the multi-sided drum 8b will be built up, because the gas return line 28 is closed and no gas can leave the interior of the drum. The result is that the liquid refrigerant in drum 8b will reach a temperature above freezing.

Meanwhile, rotation of the multi-sided drum 8b is continued and the warm refrigerant liquid now contained therein, in circulating back and forth through the freezing pipes 46, warms and gently thaws the ice immediately contacting the outer surface of freezing tubes 46.

When such thawing operation has progressed to a sufficient degree, the rotation of the drum 8b is stopped. One flat drum wall 47' and the bank of blocks of ice 60 thereon are located opposite to hinge cover 8' of the outer drum 8a, as shown in Fig. 6 when the drum is stopped.

The door 8a is then opened, and inlet and outlet flexible pipes 22' and 23' are connected respectively at 44' and 45' with the circular inlet and outlet headers 40 and 41. Also inlet and outlet valves 44 and 45 for the particular bank of ice blocks opposite door 8' are opened. Circulation pump 39 is then started and the warm thawing liquid from heat exchanger 19 is circulated through pipe 22 and passages 42, 42' and 43 for the particular bank, and back through pipe 23 whereby each ice block is warmed slowly and gently to thaw the ice film immediately around the corner of the block adjacent the shallow rectangular projecting ledge formed by members 66 and 67.

When the contacting surfaces of the ice blocks with freezing tubes 46 and plates 47' have been sufficiently thawed, the blocks 60 are removed from the freezing tubes 46 through the door 28' and may be handled down chute 61 to a place of storage, use, or transportation.

Thereafter, the next bank of blocks is moved to a position opposite door 8' and the thawing operations just described are again carried out to harvest the blocks of ice on the next bank of the multi-sided drum 8b. These operations are repeated until all of the blocks of ice have been harvested, whereupon pump 39 is stopped, flexible pipes 22' and 23' are disconnected, and a new freezing cycle is commenced.

As previously stated, if the freezing tubes 46 are slightly tapered, the thawing time for removing or harvesting the ice blocks from the freezing tubes will be shortened.

As indicated in the foregoing description, the present invention enables the manufacture of commercial ice blocks by using direct expansion of the primary refrigerant and eliminates the use of brine as an intermediate or secondary cooling medium. However, it is to be understood that the other features and advantageous results of the present invention (including rapid freezing, elimination of separate aerating equipment, purer ice formed, etc.) may be obtained, even though a brine or secondary refrigerant system is used in which the primary refrigerant is expanded to cool the brine and the brine is then passed into and circulates within the interior of the multi-sided drum 8b and the freezing tubes 46. In event that brine is used, the liquid level of the brine refrigerant within the multi-sided drum would have to cover tube 47 so that the outgoing brine would flow out of the multi-sided drum.

While the spacing of the tubes of each group is not critical, the tube spacing is important from

the standpoint of production, or rate at which it is desired to produce ice. Obviously, the closer the freezing tubes 46 are to each other, the more tons of ice per day can be produced in a unit of given size. However, the spacing must not be too close, because the ratio of hole volume to ice in any block produced may be too high for some particular use for the ice.

The presence of the holes in the ice, where the freezing tubes 46 were located during formation of the ice blocks, does not detract in any manner from the usefulness of the ice, and in fact it may be beneficial in connection with certain uses for the ice. Thus, a great deal of ice is used in relatively small quantities at isolated places, such as for packing and shipping fish and vegetables. In such instances, the ice is usually crushed or broken up in small pieces and the presence of the holes in the ice blocks will assist in enabling the ice to be readily crushed or chipped.

If the tubes are spaced, say two inches apart, four times as much ice per day can be made in the same unit under the same conditions as could be made if the freezing tube spacing were four inches apart. This is because the rate of freezing is inversely proportional to the square of the thickness of ice frozen.

Accordingly, the production desired from any particular unit and the frequency with which the ice may be harvested, determines to a large extent, the spacing between the freezing tubes. With any given spacing of freezing tubes, the size of the block of ice formed in a given time by any group of tubes may be increased simply by increasing the number of tubes in the group while maintaining the same spacing.

The freezing tubes 46 are preferably cylindrical tubes in order to provide the necessary strength to withstand the pressure of direct expansion refrigerating medium introduced within the tubes for freezing successive tubular ice films thereon. These tubes may be approximately 35'' long where it is desired to form a standard block of ice, although the tube length may be much shorter, say 8'' to 10'' in length if it is desired to form ice blocks of other sizes.

The tubes may have an internal diameter of from ⅛'' to 1''; tubes having a ½'' internal diameter being preferable. The tube wall should be as thin as possible for the particular metal from which it is formed in order to cut down power loss, but the tube wall must be thick enough to supply the necessary strength for resisting pressure. I have found that ½'' internal diameter tubes with a $\frac{1}{16}$'' wall thickness 35'' long and spaced 2'' apart are preferable in the ordinary installation for rapidly making commercial ice blocks. In every instance, the tubes having dimensions within the approximate ranges specified may be characterized as "slender" or "finger-like" tubes because of their relatively small diameter with respect to their length; and the tube arrangement or grouping may be termed a porcupine arrangement.

It will be further understood that the improved freezing apparatus may be operated in accordance with the present invention, for say eight or twelve or sixteen hours a day to produce the desired quantity of ice, and the unit may be shut down for the remaining time of a twenty-four hour period or over week-ends without substantial power loss during the shut-down period, in contrast with the normal operation of commercial ice plants in accordance with conventional practice, where it is difficult to shut down the freezing equipment without substantial power loss, and where a freezing cycle for freezing the ordinary 300 pounds commercial ice blocks is approximately forty-two hours with 14° F. brine.

It is pointed out that the ability to confine primary direct expansion refrigerant within the multi-sided drum, the ability to use small round freezing tubes with thin walls which will withstand the internal pressure of the expansible refrigerant, and the ability to use the liquid refrigerant under different conditions of temperature and pressure for both freezing and sufficient thawing to release the formed ice blocks; enables the use of direct expansion of a primary refrigerant in the manufacture of commercial ice blocks, which has heretofore been believed and considered impossible.

Accordingly, the present invention provides for the manufacture of commercial ice blocks using direct expansion of the primary refrigerant; provides for the rapid manufacture of commercial ice blocks with a relatively small capital investment; provides for the economical manufacture of commercial ice blocks in small plants at or near to the place of ultimate use of the ice, or in portable or mobile units; provides for the manufacture of ice blocks of any desired or selected weight for any one installation; eliminates the necessity of using ice cans and attendant crane, circulating tank, compressed air, thawing, and core processing equipment and the like; provides for the manufacture of very pure ice free of air cells and foreign substances without auxiliary equipment for eliminating air and foreign substances; provides for the intermittent manufacture of commercial ice blocks without substantial power loss during shut-down periods; and eliminates much of the equipment, labor attention, power, and overhead required for the manufacture of ice in accordance with common or conventional practice.

The new and improved apparatus for the manufacture of ice shown and described, but not claimed herein, is claimed in my copending application entitled "Ice manufacturing apparatus," filed of even date herewith, Serial No. 496,565.

Having now described the features of the invention, the preferred steps used in carrying out the improved method, the advantages and results obtained by the use of the same, and the prior art difficulties eliminated; the new and useful methods, steps, and operations, and reasonable mechanical equivalents thereof obvious to those skilled in the art, are set forth in the appended claims.

I claim:

1. The method of making an ice block which includes the steps of intermittently during the freezing operation immersing a group of spaced parallel tubular bodies in a bath of water, internally refrigerating the bodies, to freeze the water to form ice entirely around the exterior of each body progressively outward from the outer surface of each body until the ice formed on the group of bodies merges into one block.

2. The method of making an ice block which includes the steps of intermittently during the freezing operation immersing a tubular body in a bath of water to provide successive films of water entirely around the exterior thereof, introducing liquid refrigerant at a temperature below 32° F. internally of the body to freeze successive tubular ice films from the successive water films between successive immersions until a

desired block of ice is formed entirely around the exterior of the tubular body, then introducing liquid refrigerant at a temperature above 32° F. internally of the body to thaw the ice film adjacent the outer surface of the body, and then removing the ice block from the body.

3. The method of making an ice block which includes the steps of continuously moving a group of spaced parallel tubular bodies in a circular path into and out of a bath of water to provide successive films of water entirely around the exteriors of the tubular bodies and internally refrigerating the tubular bodies to freeze the films of water to form ice entirely around the exterior of each tubular body until the ice formed on the group of tubular bodies merges into one block.

4. The method of making an ice block which includes the steps of intermittently during the freezing operation immersing a group of spaced parallel tubular bodies in a bath of water to provide successive films of water entirely around the exterior thereof, introducing liquid refrigerant at a temperature below 32° F. internally of the tubular bodies to freeze successive tubular ice films from the successive water films between successive immersions until a desired block of ice is formed entirely around the exterior of the tubular bodies, then introducing liquid refrigerant at a temperature above 32° F. internally of the tubular bodies to thaw the ice film adjacent the outer surfaces of the tubular bodies and then removing the ice block from the tubular bodies.

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